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ABSTRACT

THESE FOUR STUDIES IN A SERIES DEAL WITH GOOD AND POOR READERS' UTILIZATION OF SELECTED CUES IN PAIRED-ASSOCIATE LEARNING. SPECIFIC CUES CONSIDERED WERE COLOR, ORDER OF PRESENTATION, AND VERBAL MEDIATORS. ANSWERS TO TWO BASIC QUESTIONS WERE SOUGHT: (1) DO THE SELECTED CUES HAVE A FACILITATIVE EFFECT UPON CHILDREN'S PAIRED-ASSOCIATE LEARNING? (2) IS THE LEARNING OF GOOD AND POOR READERS AFFECTED DIFFERENTLY BY THE ADDITIONAL CUES? FOR THE 72 ELEMENTARY SCHOOL SUBJECTS IN THE STUDY, COLOR WAS SHOWN TO HAVE A POSITIVE EFFECT UPON LEARNING WHEN INTRALIST SIMILARITY WAS HIGH, BUT THERE WAS NO RELIABLE DIFFERENTIAL EFFECT FOR GOOD AND POOR READERS. SERIAL (AS OPPOSED TO SCRAMBLED) ORDER OF PRESENTATION WAS SHOWN TO ENHANCE BOTH INITIAL LEARNING AND RECALL. INSTRUCTIONS TO USE VERBAL MEDIATORS ALSO ENHANCED LEARNING; BUT AGAIN THERE WAS NO DIFFERENTIAL EFFECT FOR GOOD AND POOR READERS. INTERACTIONS AMONG THE SELECTED CUES AND OTHER RELEVANT FACTORS AND IMPLICATIONS WERE CONSIDERED IN TERMS OF CONSTRUCTING A PROGRAM FOR THE TEACHING OF READING. (AUTHOR/JS)

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Technical Report No. 53

INVESTIGATIONS OF THE ROLE OF SELECTED CUES IN CHILDREN'S PAIRED-ASSOCIATE LEARNING

By Wayne Otto and Carin Cooper

Report from the Reading Project
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PREFACE

Four related experiments on the relationship of selected cues and reading ability on paired-associate learning are presented in this technical report. As a product of the Reading Project of the University of Wisconsin Research and Development Center for Cognitive Learning it has been assumed that the implications derived from these experiments are related to the overall problem of reading instruction and the eventual construction of a program designed to get students to learn to read.

The Reading Project is a part of Program 2, Processes and Programs of Instruction, of the Center. These experiments study instructional processes by varying cues (color, order and verbal mediators). Paired-associate learning is the dependent variable. In previous work by Professor Otto he demonstrated that reading ability is directly related to paired-associate learning (reading ability is inversely proportional to the number of trials required to learn a paired-associate list). Hence, it is implied that the cues which influence paired-associate learning may also influence learning to read.

The identification of instructional variables which influence verbal learning is an important objective of this Center.

Thomas A. Romberg
Director of Program 2,
Processes and Programs
of Instruction

ABSTRACT

Four studies in a series dealing with good and poor readers' utilization of selected cues in paired-associate learning are reported. Specific cues considered were color, order of presentation and verbal mediators. Answers to two basic questions were sought: Do the selected cues have a facilitative effect upon children's paired-associate learning? Is the learning of good and poor readers affected differently by the additional cues? Color was shown to have a positive effect upon learning when intralist similarity was high, but there was no reliable differential effect for good and poor readers. Serial, as opposed to scrambled, order of presentation was shown to enhance both initial learning and recall. Instructions to use verbal mediators also enhanced learning; but again there was no differential effect for good and poor readers. Interactions among the selected cues and other relevant factors and implications for the teaching of reading are discussed.

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I
INTRODUCTION

The four studies presented in this paper dealt with the utilization of selected cues by good and poor readers in paired-associate (PA) learning. Specific cues considered were color, order of presentation, and verbal mediators. Answers to two basic questions were sought: Do the selected cues have a facilitative effect upon children's PA learning? Is learning by good and poor readers affected differentially by the additional cues? Certain cues have been shown to have a general facilitative effect, and there is evidence that even when basic intelligence is controlled good readers do better with PA learning than poor readers. The relevant studies are reviewed below.

COLOR AS A CUE

Dulsky (1935) varied the background color of nonsense word pairs and then measured recall. Recall was better when the background colors remained the same as in the learning trials than when they were changed, and the learning decrement was greater when response background colors were changed than when stimulus or total backgrounds were changed. Weiss & Margolius (1954) presented nonsense trigram stimuli and simple word responses on different colored cards and found that retention was aided by varied conditions in the following descending order: no change in stimuli or colored backgrounds; slight modification of stimuli (e.g., a square to a rectangle); no change in stimuli but change in colors; and finally, change in both stimuli and colors.

Underwood, Ham, & Ekstrand (1962) found that subjects could not recall a list of low-meaning trigrams which had originally been learned on different colored cards; but, when meaningful words were learned instead of low meaning trigrams, the words were retained after the color cues were removed. The interpretation was that with unfamiliar trigrams familiar colors became the functional stimuli, but because the adult subjects were more accustomed to responding to words than to colors the familiar words were the functional stimuli. Jenkins & Bailey (1964) attempted to control cue selection in a study that was a replicate of the Underwood, Ham, Ekstrand study with the exception that the subjects were asked to spell out the trigrams and to name the colors; but these additional activities had no significant impact upon performance.

Saltz (1963) alternated learning and test trials and presented color cues only during learning or during testing. The color cues enhanced performance in both conditions, and Saltz concluded that cognitive differentiation had occurred during the learning trials and sensory differentiation had occurred during the testing trials.

Hill & Wickens (1962) separated the form and color components of the stimuli and had the subjects associate the components combined or separately with the common word responses. The best results were attained by the subjects who learned the components separately and then responded to a combination in final testing. Because many subjects responded correctly to only one component before a combination was formed, the authors rejected the theory that both components might summate to evoke a response. They concluded that two cues were more helpful than one because each subject was free to choose his functional stimulus. Birnbaum (1966), alternating study and test trials, provided secondary color cues on the study trials only. After intervening tasks, she presented half of her subjects with the same task and the others with the same stimulus-response pairs but different secondary color cues. The latter group did less well on the posttest in spite of the fact that the stimulus-response pairs were unchanged.

Crannell (1964), using black-and-white or colored stickers associated with a letter, numeral, or simple word, concluded that color

cues were not useful in this task because it was too easy; that is, differentiation on the basis of color occurs mainly in more difficult learning tasks. Sunderland & Wickens (1962) also concluded that context cues are not used when the primary stimuli are highly discriminable. They found that color did not significantly facilitate learning either simple words or nonsense syllables; yet, when color was removed on transfer trials the subjects made more errors on the nonsense syllable list but performance on the meaningful list did not change. However, when the primary stimuli were removed, performance on the nonsense syllable list was not affected, indicating that color was the functional stimulus, while performance on the meaningful word list dropped off significantly.

Newman & Taylor (1963) found that secondary color cues were used more when the primary stimuli were highly similar. They taught four groups of subjects either high- or low-similarity lists on colored cards and presented either the same color cues or no color cues on transfer trials. Performance deteriorated most among the subjects who had learned the high-similarity list and then were deprived of color cues on the transfer trials.

Jones (1965) examined the value of color as an aid to visual discrimination of words and letters among nursery school children. He concluded that without color the task of matching letters and words was "at least three times" as difficult as with color, even when possible color matching was considered. Also, he noted that the subjects strongly preferred the colored test materials. The implication seems to be that color may have value both as an aid to discrimination and as a motivational device in early reading.

SYNTACTICAL STRUCTURE AS A CUE

Jensen & Rohwer (1965) gave PA and serial learning tasks to children of various ages (5-17 years), with half the subjects receiving instructions to mediate verbally. Mediation did not facilitate serial learning for any age level, while it greatly benefited PA learning for all ages except 5, 13, and 17. The older subjects presumably did not differ because the task may have been too easy for them, and they may have been mediating even when not instructed to do so.

Davidson (1964) provided verbal mediators varying in amount of syntactical structure for pairs of pictures. He found that the subjects learned faster when a single preposition was used as a mediator than when the pictures were just named, and that the preposition was as effective a mediator as was a nine-word sentence plus a juxtaposition of the pictures to depict the sentence.

Rohwer (1964) varied semantic structure (English words vs. nonsense words), syntactic structure (grammatical vs. scrambled order), and constraint (pairs connected with a conjunction, a preposition, or a verb). He concluded that both semantic and syntactic structures are needed to facilitate PA learning, and that these conditions must be accompanied by a preposition or a verb.

READING ABILITY AND PA LEARNING

Walters & Doan (1962) studied good, average, and poor readers in a task requiring them to associate colored lights with different compartments of a box. The poor readers took significantly more trials to learn than did the good and average readers, who did not differ. The authors concluded that the poor readers were deficient in associative ability. In a similar study, Walters & Kosowski (1963) used the same task as above but added another task that paired different tones with the compartments of the box. The poor readers learned much more slowly than the good and average readers on both tasks, but a transfer effect from one task to the other eliminated the differences between the subjects. Also, the poor readers, when rewarded with a prize, did as well as the others, indicating that practice and attention to stimuli may be important factors in the relationship between reading ability and PA learning.

Giebink & Goodsell (1967) compared kinds of visual-auditory tasks, using good and poor readers with visuomotor deficits as subjects. The good readers performed better than the poor, and the word-like figures were easier for the subjects to associate with a spoken word than were the geometric stimuli.

Otto (1961) required good, average, and poor readers to learn a list of geometric form-CVC trigram pairs with one of three modes of reinforcement—auditory, visual, or kinesthetic. The good, average, and poor readers differed from each other, showing that with an increase in reading ability, there was a decrease in number of trials to criterion. Mode of reinforcement interacted with grade level, but not with reading level. In relearning, there was no significant reading level effect.

II
EXPERIMENT I[1]

The basic purpose of this study was to determine whether elementary school children's paired-associate learning would in fact be enhanced by the introduction of color into the list. A secondary concern was whether good and poor readers' learning would be affected differently by the additional cue. The speculation was that perhaps poor readers would benefit from the color cue but good readers would not because they were already able to handle the task efficiently. The same reasoning would, of course, lead to an expectation of greater facilitation of learning for pupils in the lower grades. Because the study was primarily exploratory, there was no attempt to provide for clarification of reasons for possible differential effects.

METHOD

Subjects and Design

Subjects were good and poor readers from Grades 2, 4, and 6 of a public and a parochial elementary school in a small city. All potential subjects were required to have IQs in the average (90-115) range according to test scores corroborated by teacher judgment. Pupils with average IQs who could not be clearly classified as good or poor readers were rejected as subjects. Good readers were those pupils who, according to test scores and teacher judgment, were in the upper third of their class in reading achievement; poor readers were those were clearly in the lower third.

From the pool identified, equal numbers of boys and girls from each reading level and each grade level were assigned to the two methods of presentation for a total of 72 subjects. Thus, the design was 2 (boys and girls) x 2 (good and poor readers) x 3 (Grades 2, 4, and 6) x 2 (black-and-white and color presentation) with three replications.

Task

The paired-associate list was devised and used in an earlier study (Otto, 1961). Briefly, the list comprised five pairs, a common geometric form and a consonant-vowel-consonant trigram with a 25% or lower association value according to the Archer (1960) list: diamond-fep, circle-niv, triangle-wuc, star-yad, square-gox. Depending on the method of presentation, both stimulus and response were presented either in black-and-white or in color. Colors used, in the same order as the above list, were blue, red, brown, orange, and green.

Procedure

Individual subjects learned the list to a criterion of one correct anticipation of the entire list with serial presentation and one correct anticipation of the entire list with scrambled presentation: total score, then, was the sum of serial and scrambled trials. This unconventional sequence of presentation was devised when immediate scrambling of the list proved disconcerting to younger subjects.

An MTA-100 Scholar timed by a Cousino Audio Announcer was used to present the list. An overlay with a 7" x 1" opening was affixed to the display face of the Scholar. By manipulating a slide, the experimenter was able to expose 1 1/2" x 1" portions of the total opening; and the stimulus sheet was so arranged as to permit five different orders of presentation. Figures and trigrams were 3/8" high. The stimulus form was presented for 4 seconds followed by a 4-second presentation of

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[1]An expanded report, "Color Cues as an Aid to Good and Poor Readers' Paired-Associate Learning," was presented at the annual International Reading Association meeting, Seattle, 1967 (Otto, 1968a).

both stimulus form and response trigram, during which the experimenter enunciated the trigram name. Each pair was followed by a 4-second rest, and each presentation of the entire list was followed by a 10-second intertrial rest.

All testing was done in a private room with a minimum of distraction. Subjects were told that they were helping the experimenter to learn how children learn. The fact that the pairs would be in either black-and-white or color was not pointed out, and the fact that color was used was never spontaneously mentioned by a subject. A preliminary trial with a stimulus pair (heart-keb) was given to explain the nature and sequence of the task. All subjects were tested by the first author.

RESULTS AND DISCUSSION

The mean acquisition trials—serial, scrambled and total—are given by main effect in Table 1. It should be noted here that the grand mean for total trials was 9.7; but with visual-auditory presentation in an earlier study (Otto, 1961)—where the task and method of presentation, with the exception of the added color cues, were the same as in this study—the grand mean for the visual-auditory group (N = 36) was 12.3. This discrepancy between the results of the present and the earlier study is noted because there are implications for the interpretation of the present findings. Other specific discrepancies between the two studies are noted for the same reason.

Separate analyses of variance of serial and of scrambled trials showed that only the Grade and Reading Level main effects were significant ($p < .005$) with serial trials; none was significant with scrambled trials; and there were no significant interactions shown in either analysis. The effect of scrambling the presentation apparently was the same for all subjects, with the initial serial learning trials accounting for the differences. An analysis of variance of total learning trials revealed that only the Grade ($F = 11.4$, $df = 2/48$, $p < .005$) and Reading Level ($F = 23.71$, $df = 1/48$, $p < .005$) main effects were significant, and none of the interactions reached significance. Table 1 shows that second graders took more trials than fourth and sixth graders, but there is little difference between fourth and sixth graders' mean trials. This finding, too, is different from the earlier study, where second, fourth, and sixth graders all differed. The poor readers required significantly more trials than the good readers to master the list, but again there is a possibly significant discrepancy from the earlier results: in the present study good readers required 8.3 and poor readers required 11.0 mean trials, whereas in the early study good readers required 8.7 and poor readers required 15.3 mean trials. Thus, the good readers in both studies performed similarly, but the present poor readers required substantially fewer total trials.

The Method of Presentation main effect did not approach significance, nor were any of the interactions significant. Yet, in view of the speculation that perhaps poor readers and lower grade pupils would benefit most from color cues, the following interaction tables show some interesting trends. The means in Table 2 show that it was the good readers who

Table 1. Mean Acquisition Trials

	Grade			Sex		Reading Level		Method	
	2	4	6	M	F	G	P	B-W	C
Serial	8.5	6.7	5.9	6.8	7.2	5.9	8.1	7.2	6.9
Scrambled	3.0	2.2	2.6	2.8	2.5	2.4	2.9	2.7	2.5
Total	11.5	8.9	8.5	9.6	9.7	8.3	11.0	9.9	9.4

Table 2. Mean Total Trials: Reading Level x Method of Presentation

Reading Level	Method of Presentation	
	Black-White	Colored
Good	8.9	7.7
Poor	11.0	11.1

tended to benefit more from color cues; and the means in Table 3 show a trend toward increasing benefit from color cues with increasing grade level. Both trends are directly opposite of the prestudy speculation.

Table 3. Mean Total Trials: Grade x Method of Presentation

Grade	Method of Presentation	
	Black-White	Colored
2	11.4	11.7
4	9.2	8.7
6	9.3	7.8

Because the analyses revealed that the present results were generally nonsignificant, very little that is unequivocal can be said. Yet the expectation that more efficient paired-associate learning should result from the addition of color cues is based upon sufficiently strong theoretical and empirical grounds to make examination of the present contradictory results worthwhile. Post hoc speculation, then, is offered with full awareness of the limitations.

The experimenter did not point out or discuss the color cues, so it would have been necessary for individuals to discover their own use for the color cues. Not one of the subjects commented on the varied colors. And, when the experimenter informally queried some of the subjects several days after the testing, they were unable to recall whether the task had been presented in black-and-white or in color. The followup was not done systematically, but the informal feedback seems to suggest that perhaps the subjects did not use color cues either because they were frankly not consciously perceived or because they did not see a way of making systematic use of them. Of course, there is a possibility of "unconscious mediation" as demonstrated by Bugelski and Scharlock (1952), but it apparently was not strongly operative in this study. Yet, if the argument that the subjects were unaware of the color is to stand, the trends noted—i.e., more efficient learning with color cues by good readers and upper grade pupils—must be explained [illegible]erms of unconscious mediation. A replication of the present study with explicit instructions regarding color cues would be worthwhile.

Another possibility is that, as the present paired-associate task was structured, the interjection of color did not amount to provision of a more meaningful or more useful cue. Dissimilar geometric forms served as stimuli in the present task, whereas in the related studies reviewed trigrams were the stimuli and color was added only to the stimulus portion of each pair. The geometric forms used here were dissimilar by design and, therefore, perhaps so discrete that further differentiation or cue selection was not useful. Of course, the present list was also atypical in that both stimulus and response components were in color. The reasoning was that this might encourage color mediation, but the effect may have been merely to erase the salience of color as a cue. This, unfortunately, does not explain the lack of any motivational effect arising from the use of color; but perhaps only very young children, such as those studied by Jones, benefit directly from color in this way.

To offer an explanation for the unexpected trend by good readers and upper-grade pupils to do better with color is difficult. The speculation already given is, if anything, at odds with this trend. One could dismiss it as nonsignificant, but the fact is that the trend is opposite of that expected and, therefore, particularly UNserendipitous. Another study of good and poor readers' paired-associate learning is needed to determine whether the trend is a stable one. If it is, then further efforts to find out why will be in order.

Finally, the present subjects took fewer trials, regardless of method of presentation, to master the list than did subjects who learned the same list in the earlier study. As already noted, however, the means for good readers in the two studies were very similar; the difference was between poor readers' means, with the present subjects taking substantially fewer trials. Obviously there was some discrepancy between either the choice of poor readers and/or the administration of the task in the two studies. The most straightforward suggestion seems to be that the present poor readers may have been better readers: poor readers in the earlier study were chosen from among pupils whose reading test scores placed them in the bottom three stanines on national norms, whereas the present poor readers were from the bottom third of their classes according to test scores and teacher judgment. The discrepancy is relevant here mainly because different results might have been obtained with regard to color cues if the poor readers had been pupils with severe reading problems.

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III
EXPERIMENT II[2]

The absence of a significant overall color-cue effect in Experiment I could be explained in one of several ways: the geometric forms in the form-trigram list were so dissimilar that further differentiation or cue selection was not useful; the effect of presenting both the stimulus and response portions of each item in the same color may have been to decrease the salience of color as a cue; and the use of color was not discussed with the subjects who were given color cues, and there was some subjective evidence that they were unaware of the systematic use of color. In Experiment II, the PA task was more reading-like and the stimulus components were not as dissimilar as in Experiment I; also, subjects receiving color cues were informed of their presence. The basic question was whether performance would be enhanced by the provision of color cues with the revised task. A related question was whether or not the previously demonstrated tendency for good readers and for upper-grade subjects to benefit more from the color cue would again be demonstrated.

METHOD

Subjects and Design

Subjects were good and poor readers from Grades 2, 4, and 6 of the two elementary schools in a small city. Potential subjects scored in the average (90-115) range on the *Quick Test*, an individually administered picture vocabulary test, which was given to all second, fourth, and sixth graders in the two schools. Those who scored in the bottom four stanines on the reading subtests of an achievement battery were designated poor readers and those who scored in the top four stanines were designated good readers. From the pools of pupils so identified, equal numbers of boys and girls from each reading level and each grade level were assigned to the two methods of presentation for a total of 72 subjects.

Task

The task was reading-like in that it approximated sight word learning. The stimuli, presented visually, were six three-letter words written in Greek characters and the responses, given orally, were the English words *ask*, *ear*, *few*, *had*, *men*, and *sea*. Thus, the stimuli were dissimilar in that each began with a different unfamiliar character; but characters did recur in other positions. Depending on the method of presentation, the stimuli were printed in black or in distinctive colors. The colors used for each of the six stimuli, given in the same order as the words above, were brown, red, orange, blue, green, and pink.

Procedure

Each stimulus was printed in 3/4" characters on a separate 3" x 5" card. The stimulus cards were presented manually by a tester, who enunciated the appropriate response portion of each pair. Subjects were told the words to be associated with each stimulus on the first trial. On subsequent trials each stimulus was displayed for approximately 4 seconds, then the tester gave the correct response and waited about 4 seconds more before going on to the next stimulus. An intertrial rest of about 12 seconds was given, so the subject knew when the list was to be repeated.

All testing was done individually in a private room with minimal distractions. Subjects were told that they were helping the tester to learn how children learn. The tester made

[2]An expanded report, "Elementary Pupils' Use of Cues in Paired-Associate Learning," will be published in *Psychology in the Schools* (Otto, 1968b).

explicit mention of the presence of color when the colored stimuli were used. Each subject learned the list to a criterion of one correct anticipation of the entire list with serial presentation and one correct anticipation of the entire list with scrambled presentation; total score, then, was the sum of the serial and scrambled trials. This sequence of presentation was preserved from earlier studies (Otto, 1961; Experiment I) where it was observed that immediate scrambling was disconcerting to the younger subjects, particularly the poor readers. The feeling was that the naturalistic appeal of manual presentation more than offset any disadvantages attributable to the loss of precise control of presentation times.

RESULTS AND DISCUSSION

The mean numbers of trials required to reach the criterion of one correct anticipation of the entire list with serial presentation and with serial plus scrambled presentation are given in Table 4 by main effect. Comparison of the serial and total trials means shows that the number of trials required to reach criterion with scrambled presentation differed markedly for certain of the subgroups. This was different from the two earlier studies where the serial plus scrambled sequence was followed; the finding had been that the effect of scrambling was quite uniform across subgroups and analyses of serial and total scores yielded similar results.

An analysis of variance of serial learning trials was performed. The F for the Grade ($F = 16.57$, $df = 2/48$, $p < .01$), the Reading Level ($F = 8.79$, $df = 1/48$, $p < .01$), and the Method of Presentation ($F = 4.54$, $df = 1/487$, $p < .05$) effect was significant. A Scheffé test showed that second graders took more trials than fourth and sixth graders; and inspection of Table 4 shows that poor readers took more trials than good readers and that subjects with black-and-white presentation required more trials than those with colored presentation. The F did not reach significance for any of the interactions. The total learning trials analysis revealed a significant F only for the Sex ($F = 4.19$, $df = 1/48$, $p < .05$) and the Method of Presentation ($F = 4.89$, $df = 1/48$, $p < .05$) effects; boys required more total trials than girls and fewer trials were again required with the colored presentation. There were no significant interactions.

The question of whether the previously observed trend for good readers and upper-grade subjects to benefit more from color cues is answered in Table 5 and Table 6. The interaction effects shown did not reach acceptable significance levels, as already noted. There was an opposite trend, however, for the second graders to benefit disproportionately more than fourth and sixth graders from the color presentation; but there was no discernable trend on the basis of reading level. The data in the interaction tables also help to specify the cause for the shift in results from the serial to the total trials analysis: good readers who learned the black-and-white list required more scrambled trials than the other groups, which tended to neutralize the Reading Level difference that existed after serial learning when total trials were considered; and the fact that the second graders, particularly those who learned the colored list, required fewer scrambled trials than the fourth and sixth graders had a similar effect with regard to Grade Level.

Table 4. Mean Acquisition Trials

	Grade			Sex		Reading Level		Method	
	2	4	6	M	F	G	P	B-W	C
Serial	7.9	4.0	4.4	5.9	5.0	4.6	6.3	6.1	4.8
Total	10.4	8.5	9.2	10.4	8.3	9.0	9.8	10.5	8.3

Table 5. Mean Serial (in parentheses) and Total Trials: Reading Level x Method of Presentation

Reading Level	Method of Presentation			
	Black & White		Color	
Good	(4.9)	10.1	(4.2)	7.9
Poor	(7.2)	10.8	(5.4)	8.6

Table 6. Mean Serial (in parentheses) and Total Trials: Grade x Method of Presentation

Grade	Method of Presentation			
	Black & White		Color	
2	(9.3)	12.5	(6.4)	8.3
4	(4.2)	9.8	(3.9)	9.3
6	(4.8)	9.2	(4.4)	8.3

Analyses of both serial and total trials showed that learning was enhanced by the provision of color cues with the present reading-like task. In view of the lack of such an effect with the form-trigram list, the suggestion is that the nature of the paired-associate list is a significant determiner of whether a facilitative effect will be demonstrated. If the color cue became useful because of increased intralist similarity in the present task, then the effect might be attributed to increased differentiation through the use of color. On the other hand, the effect might have been due to cue selection. That is, color alone may have become the functional stimulus for each pair and learning then would have been enhanced by the change from relatively complex and unknown word-like stimuli to simple and known color names.

The present data offer no basis for choosing between differentiation and cue selection to explain the facilitative effect of color. This is unfortunate, because the issue is more than academic. In a very practical sense, the use of color in teaching sight words would have a salutory effect upon reading ability if the colors were useful for purposes of differentiation; but no useful purpose would be served if the color rather than the words became the functional stimuli. In another study it will be worthwhile to examine subjects' performance with a black-and-white list immediately after mastery of the list with color. Previous work of this nature has been confined mainly to adult subjects and the tasks involved have not necessarily been reading-like in nature (e.g. Underwood, Ham & Ekstrand, 1962; Saltz, 1963). Now that the facilitative effect of color has been demonstrated with children and the task restrictions are more clearly understood, the way is clear to seek reasons for the facilitation and to examine possible applications. The clarification of principles through the specific study of color cues should, of course, generalize to other types of cues; herein lies the potential value of such a line of research.

The shift in results from the serial trials analysis to the total trials analysis was clearly due to the fact that the effect of scrambling the presentation was not uniform across subgroups. A recent study by Samuels and Jeffrey (1966) offers some clues as to why this would have been so with the present list but not so with the geometric form-trigram list used in the related studies. Their finding, with kindergarten age subjects, was that when intralist similarity is high, serial order of presentation is superior to scrambled order, but when intralist similarity is low, the order of presentation seems unimportant. The authors suggested that the consistency of serial presentation makes it easier for subjects to discriminate between similar items and that learning is thereby enhanced even when the items are scrambled after a number of trials. It might be argued, then, that when intralist similarity is low, e.g. when the stimuli are distinctive geometric forms, subjects would tend uniformly to attend to the stimuli rather than to other salient cues, such as the serial order or color; thus, the effect of changing from serial to scrambled presentation would be both slight and fairly uniform for all subjects. On the other hand, with increased intralist similarity, as in the present task, subjects would be more apt to select from the available cues, i.e. "words," colors or serial order in the present list; those who made extensive use of the serial order would need to do extensive relearning with scrambled presentation.

In such a framework a post hoc explanation for the difference between the serial and total trials analyses can be quite straightforward; but the obvious lack is that it is not possible to say why a particular group chose a particular cue. For example, it has been pointed out that the shift from a significant to a nonsignificant Reading Level effect was due primarily to the fact that the good readers who responded to the black-and-white list took more trials to reach criterion when the list was scrambled. Apparently they had been most heavily dependent upon order of presentation, rather than color or the "word" itself, in learning the list serially; but why they should have been so is not clear. Likewise, second graders, particularly those who responded to the colored list, reached criterion with the scrambled presentation in fewer trials than either the fourth or sixth graders, which was largely responsible for the shift from a significant to a nonsignificant Grade effect. Apparently the second graders made less use of order in their serial learning and more use of color when it was available. Again the reason is not clear, but the need for further investigation of the variables that effect cue selection is quite clear.

IV
EXPERIMENT III[3]

The results of Experiment II suggest that some subjects may have been using serial order of presentation as a cue, which is in line with the suggestion by Samuels and Jeffrey (1966) that serial presentation is superior to scrambled when intralist similarity is high; and second graders tended to make more use of color cues than the fourth and sixth graders. Experiment III, then, was done to examine the relative roles of and possible interactions among intralist similarity, order of presentation, and color in paired-associate learning among second-grade subjects.

METHOD

Two basic lists were prepared. The high similarity list comprised six whimsical, word-like stimuli that were made up of three Greek letters arranged in every possible three-letter combination. The low similarity list also comprised six stimuli, but they were made up of eighteen Greek letters, none of which occurred more than once. Some liberties were taken with certain Greek letters to avoid duplication of Roman letters with which the *S*s were familiar. Orally presented English words —***ask***, ***ear***, ***few***, ***had***, ***men***, and ***sea*** —served as responses. The stimulus words were printed on 3" x 5" cards in 1" characters, either in black or in six distinctive colors—green, light blue, brown, orange, red, and purple.

The subjects were 144 second graders, equal numbers of boys and girls selected at random from two schools. Ninety-six of the *S*s were assigned to the eight basic groups, six boys and six girls to each group, included in the 2 (high and low intralist similarity) x 2 (serial and scrambled presentation) x 2 (colored or noncolored stimuli) design schematically represented in Table 7. The remaining subjects were assigned to four groups and exposed to selected precriterion learning conditions (see Table 7, groups in brackets) in order to permit additional postcriterion cue shifts; data from these groups were not considered in the acquisition trials analyses.

Table 7. Schema of the Basic Design and Postcriterion Learning Conditions

Precriterion			Postcriterion
High Similarity (Hi)	Serial (Ser)	No color (Nc)	Nc Scr
		Color (C)	Nc Scr
			[C Scr]
			[Nc Ser]
	Scramble (Scr)	No color (Nc)	Nc Scr
		Color (C)	Nc Scr
Low Similarity (Lo)	Serial (Ser)	No color (Nc)	Nc Scr
		Color (C)	Nc Scr
			[C Scr]
			[Nc Ser]
	Scramble (Scr)	No color (Nc)	Nc Scr
		Color (C)	Nc Scr

Each subject was shown the appropriate list of six "words," told the response to be associated with each stimulus, asked to repeat each response, and then told that on subsequent trials he was to attempt to give the response before it was given by E. Stimulus cards were presented manually. An approximate 4-second interval before E gave the response was followed by another 4-second interval until the next card was presented. The cards were shuffled between trials for the scrambled presentations. The criterion was two correct consecutive anticipations of the entire list or 15 trials. A single postcriterion

[3]An expanded report, "Intralist Similarity, Order of Presentation and Color in Children's Paired-Associate Learning," will be published in *Psychonomic Science* (Otto, 1968c).

trial was given immediately. The nature of the list (stimuli colored or noncolored) and the order of presentation were systematically varied on the postcriterion trial (see Table 7) in order to obtain data relevant to the importance of order of presentation and color as cues.

RESULTS AND DISCUSSION

Separate analyses of variance of correct responses on Trials 3, 6, 9, 12, and 15 were run. The notion was that perhaps there would be some differences in results across precriterion trials, but each analysis yielded similar results: significant Intralist Similarity and Order of Presentation effects, a nonsignificant Color effect, and a single significant interaction—Intralist Similarity x Order of Presentation. Specifically, these results are exemplified by the Trial 15 analysis, where the Intralist Similarity effect (df = 1/88, F = 25.49, $p < .001$), the Order of Presentation effect (df = 1/88, F = 59.39, $p < .001$), and the Intralist Similarity x Order of Presentation interaction (df = 1/88, F = 22.88, $p < .001$) were significant. Comparisons of means show that there were more correct responses with the low similarity list (M = 5.73) than with the high similarity list (M = 4.94) and more correct responses with serial (M = 5.94) than with scrambled (M = 4.73) presentation. The means in Table 8 clarify the nature of the interaction. The *S*s who learned the High Similarity Scrambled list differed from all other *S*s, but there were no other between group differences, according to the Scheffé post hoc test. Analyses of trials through criterion and of total correct responses through Trial 15 also yielded similar results. Thus, serial order of presentation enhanced learning but color did not, even when there was high intralist similarity.

Table 8. Mean numbers of Correct Responses on Trial 15 for High and Low Similarity Tests with Serial and Scrambled Presentation

Group	Mean
Low Similarity Serial	5.96
High Similarity Serial	5.92
Low Similarity Scrambled	5.50
High Similarity Scrambled	3.96

Comparisons of pre- and postcriterion performance are shown in Table 9. In each instance there were fewer cues—i.e. color, order or both eliminated—on the postcriterion trial. It is no surprise that there was no change when Low Similarity/No Color/Scrambled was changed to Serial; but the change when High Similarity/No Color/Scrambled was changed to Serial does present some awkwardness. Perhaps it is simply a symptom of too many t-tests. Nevertheless, the essential point seems clear: in every instance the removal of cues

Table 9. Mean Responses Correct and t-Test Results for All Groups on Trial 15 Precriterion and Trial 1 Postcriterion

Pre- and Postcondition	Pre- Mean	Post- Mean	t-Value
Hi Nc Ser - Hi Nc Scr	5.83	2.75	7.39**
Hi C Ser - Hi Nc Scr	6.00	2.75	8.74**
Hi C Ser - Hi C Scr	6.00	3.33	4.69**
Hi C Ser - Hi Nc Ser	6.00	4.75	3.05*
Hi Nc Scr - Hi Nc Ser	3.75	3.08	2.36*
Hi C Scr - Hi Nc Scr	4.17	2.67	3.59**
Lo Nc Ser - Lo Nc Scr	5.92	4.58	4.71**
Lo C Ser - Lo Nc Scr	6.00	4.67	3.74**
Lo C Ser - Lo C Scr	6.00	5.33	3.55**
Lo C Ser - Lo Nc Ser	5.83	5.00	3.46**
Lo Nc Scr - Lo Nc Ser	5.25	5.08	.53
Lo C Scr - Lo Nc Scr	5.75	4.83	3.20**

* $p < .05$

** $p < .01$

resulted in poorer performance, and this was true even when color was the only cue removed. Color may be a less potent cue than serial order, at least among second graders, but there does appear to be some value.

Apparently the cue value of color—again, at the second-grade level—is rather fragile and apt to be superseded by more potent cues. The immediate implication seems to be that color cues are better than no cues. The study should be replicated with children from other grades.

V
EXPERIMENT IV[4]

Experiment IV was designed to examine the cue value of syntactical mediation in children's PA learning. There is strong and consistent evidence that syntactical mediation greatly facilitates PA learning, and there is some evidence that good readers master a paired-associate task in fewer trials than poor readers. Perhaps good readers' superiority is due, at least in part, to spontaneous mediation. A pertinent question, then, is whether poor readers' performance would be enhanced by instructions to mediate. The purpose of Experiment IV was to examine the relationship among reading ability, grade level, and syntactical mediation in paired-associate learning.

METHOD

Subjects and Design

Subjects were second- and fourth-grade pupils in a small Wisconsin school system. Good and poor readers were identified on the basis of reading subtest scores from the Stanford Achievement Tests; those pupils who were above the 64th percentile or below the 34th percentile on all of the relevant subtests were considered good and poor readers, respectively. Total IQ scores from group intelligence tests were obtained for all good and poor readers, and an attempt was made to identify those subjects whose IQ scores were closest to their class means. The second-grade class mean IQ was 109.00 with a standard deviation of 11.14; and the fourth-grade class mean IQ was 104.88 with a standard deviation of 12.22.

Equal numbers of boys and girls from each reading level and each grade level were then selected, with each group equated on the basis of IQ scores, to receive one of two types of instructions. The mean IQs and standard deviations for each group are given in Table 10. The IQ scores for each group were ranked, with the odd-numbered ranks receiving the mediation instructions and the even-numbered ranks receiving the nonmediation instructions. Thus, the design was 2 (boys and girls) x 2 (good and poor readers) x 2 (Grades 2 and 4) x 2 (mediation and nonmediation instructions) with four replications.

Table 10. Mean IQ and Standard Deviation for Each Group

	Grade 2		Grade 4	
	Good	Poor	Good	Poor
Male				
Mean	114.50	103.63	117.88	100.13
S.D.	10.24	16.17	5.64	5.62
Female				
Mean	110.75	110.63	113.13	96.00
S.D.	4.33	10.31	4.29	5.45
Male and Female Combined				
Mean	112.63	107.13	115.50	98.06
S.D.	7.84	13.59	5.43	5.76

Task

The stimulus materials were 16 pictures of common objects, drawn with black ink on 4" x 4" squares of white poster board. The objects used were taken from and paired according to Rohwer (1964). This insured that they were high frequency nouns (classes A and AA in the Thorndike-Lorge tables) and were paired so as to minimize the association value. The pairs were MOP-CAKE, TREE-HAT, CLOCK-HOUSE, FISH-

[4]The original report, "The Relationships among Reading Ability, Grade Level, and Syntactical Mediation in Paired-Associate Learning," was the master's thesis of Carin Cooper (1968). A revised version was presented at the annual American Educational Research Association meeting, Chicago, 1968.

BED, CAT-SHOE, SOAP-FORK, COMB-GLASS, and COW-BALL. Pictures of these objects were taken from a first-grade workbook.

Procedure

Each subject was tested individually in a small room containing a table and two chairs. The experimenter and the subject sat beside each other, with the pairs of cards placed face down on the table before them. The pictures had been placed so that the stimulus picture was on top of the response picture and the pairs were ordered the same for all subjects at the beginning. On the first trial, each pair was exposed for 15 seconds and then turned face down again. Subjects receiving the nonmediation instructions were told:

> There are pictures drawn on the other side of these cards. I'm going to show you two at a time. All you are to do right now is to name them. For example, if I showed you a bird and a book, you would say, "Bird, book." Do you understand? Here are the first two.

Subjects receiving the mediation instructions were told:

> There are pictures drawn on the other side of these cards. I'm going to show you two at a time. First I want you to name them and then make up a sentence using both of those names. For example, if I showed you a bird and a book, you would say, "Bird, book. The bird is pecking at the book." Or any other sentence you can think of using those two words. Can you think of another one? (If not, the subject was prompted by being told, "There are lots of sentences with those two words. I'll give you another one, and then you give me one.") Very good. Sometimes the only sentence you can think of is a silly one, but that's all right, as long as both words are in the same sentence. Tell it to me as soon as you can think of it. Here are the first two.

If the subject could not give a sentence after 5 seconds, he was asked "Can you think of a sentence?" If he still could not give a sentence then the experimenter said, "Well, I'll tell you one." The sentences that were used if the subject could not think of one were very similar to sentences made up by third graders used as practice subjects. They were as follows:

1. I will MOP the floor after I eat the CAKE.
2. My HAT was stuck in the TREE.
3. We have a CLOCK in our HOUSE.
4. The FISH was in the BED.
5. The CAT was sleeping in the SHOE.
6. The SOAP will clean the FORK.
7. We wash the COMB in the GLASS.
8. The COW chased the BALL.

Before the second trial, all subjects were told:

> Now I will mix up the order. Now when I point to a picture, I want you to tell me which picture is underneath. Then I will show you so you can see if you were right or not. But if you take too long in answering, I will show you anyway. So try and tell me what the bottom picture is *before* I show you. If you can not remember, then take a guess. Do you understand?

One at a time, each pair was turned over so that the stimulus picture was in view for about five seconds. Then it was lifted and placed beside the response picture for another five seconds whether the subject responded or not. Then both pictures were placed face down again. Between trials, the pairs were scrambled in order. This allowed for a 10-second intertrial interval. Subjects were run to a criterion of one errorless trial or 20 trials, whichever came first.

Following the learning, all subjects were asked in an informal manner how they had been trying to remember and if they had been thinking of anything else besides the pictures they saw. This was done to identify the subjects who were mediating whether they had been instructed to or not.

RESULTS AND DISCUSSION

Using number of trials to criterion as a measure, means and standard deviations for each group were calculated (see Table 11). An analysis of variance revealed that only the Instructions ($F = 77.5$, $df = 1/48$, $p < .001$) and the Grade ($F = 6.7$, $df = 1/48$, $p < .025$) main effects were significant, and one interaction was significant, Reading Ability x Instructions x Grade ($F = 4.42$, $df = 1/48$, $p < .05$). As seen in Table 11, the fourth graders and the subjects receiving the mediation instructions learned in fewer trials.

Table 11. Mean Number of Trials and Standard Deviations for All Groups (N = 4)

	Grade 2		Grade 4	
	Male	Female	Male	Female
GOOD				
Nonmediation				
Mean	12.75	15.25	5.75	7.75
S.D.	9.74	4.99	1.71	4.65
Mediation				
Mean	2.25	2.00	1.50	1.75
S.D.	0.96	0.00	0.58	0.50
POOR				
Nonmediation				
Mean	11.00	13.25	11.50	11.75
S.D.	5.48	5.50	4.65	5.68
Mediation				
Mean	3.25	3.75	1.25	1.00
S.D.	2.50	1.71	0.50	0.00

Using the Scheffé technique of post-hoc comparisons (Hays, 1963) to analyze the significant interaction, it was found that the second-grade poor readers given mediation instructions did not differ significantly from any of the fourth-grade groups. Also, the fourth-grade good readers given nonmediation instructions did not differ significantly from any other groups. However, a t test comparison of the scores of the fourth-grade good and poor readers who were given nonmediation instructions was significant ($t = 3.09$).

To help explain the above interaction, an analysis of variance of IQ scores was performed. Reading Ability was significant ($F = 25.04$, $df = 1/48$, $p < .001$), with the good readers having higher IQs than the poor readers (Table 10). The Grade x Reading Ability interaction was also significant ($F = 6.78$, $df = 1/48$, $p < .025$); a Scheffé post-hoc comparison showed that the fourth-grade poor readers had lower IQs than all of the good readers, while the second-grade poor readers did not differ from any other group.

To gain more information about the relationship between IQ and reading ability, Pearson product-moment correlations were computed between the IQ scores and the grade equivalent scores on each of the reading subtests used for all the second and fourth graders. These coefficients are shown in Table 12. The correlations for the second grade are much lower than those for the fourth grade.

Following the learning task, all subjects had been asked what they had been thinking of to help them remember. All of the subjects given mediation instructions reported that they had been thinking of their sentences. Of the subjects given nonmediation instructions, some reported making some sort of associations between the stimuli and the responses. The number of subjects who just named the pairs is broken down in Table 13 according to whether they were mediating or not. The largest difference is between the good and poor readers in the fourth grade.

Table 12. Correlation Coefficients between IQ and Reading Scores

Grade	Stanford Achievement Subtests	Coefficient
2	Word Reading	.27
	Paragraph Meaning	.29
	Vocabulary	.35
	Word Study Skills	.21
4	Word Meaning	.72
	Paragraph Meaning	.70
	Word Study Skills	.77

A Fisher exact probability test (Siegel, 1956) was used for each grade level to test whether the number of spontaneous mediators and nonmediators among the good and poor readers differed significantly. In the second grade, the probability that the number of mediators and nonmediators did not differ was 0.4999. In the fourth grade, however, the probability was 0.0594, barely missing the one-tailed .05 level of significance. This is inter-

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Table 13. Number of Mediating and Nonmediating Namers

	Grade 2			Grade 4		
	Good	Poor	Total	Good	Poor	Total
Mediators	2	3	5	5	1	6
Nonmediators	6	5	11	3	7	10

preted to mean that about 94 times in 100, there will be more good readers than poor readers in the fourth grade who will mediate spontaneously.

A similar analysis was performed to test whether the number of spontaneous mediators and nonmediators in the two grade levels differed. As seen in Table 13, five second graders and six fourth graders were mediating. The probability was 0.5624 that these numbers did not differ. However, when broken down further by reading ability, the analogous probabilities were 0.1580 for the good readers and 0.2851 for the poor. Neither reaches a level of significance to reject the null hypothesis.

Subjects instructed to mediate learned the PA list in fewer trials than those not so instructed. In fact, this variable accounted for most of the variance, as there was little overlap between the two groups. This phenomenon has been consistently found in studies using different subject populations, different materials, and different instructions for mediation; the present results merely lend more support to this general conclusion.

The fourth graders learned in fewer trials than second graders. This replicates the results of Jensen & Rohwer (1965) which showed that performance improved with increasing age. In fact, their second- and fourth-grade groups with both types of instruction have almost the same mean number of trials to criterion as do the comparable groups in the present study, even though their PA list contained two items more. These results also compare well with the significant grade level variable found by Otto (1961).

In the present study, the good and poor readers did not differ in PA learning, unlike the subjects of Walters & Doan (1962), Walters & Kosowski (1963), Giebink & Goodsell (1967), and Otto (1961). However, the task used in the present study involved a visual-visual association that was different from the visual-visual and visual-auditory tasks used in the other studies. Therefore, the results of the present study may lend some support to the hypothesis that good and poor readers will differ in number of trials needed to learn a PA list only under certain task conditions.

Since the main effects of Grade and Instructions were significant, the interaction of Reading Ability x Instructions x Grade may be due to the difference between the good and poor readers in the fourth grade who received nonmediation instructions. The good readers had learned in significantly fewer trials than the poor readers. There are two possible explanations for this better performance: (1) differences in IQ may account for the differences in performance, and (2) more of the fourth-grade good readers were mediating spontaneously than the fourth-grade poor readers. Each of these possibilities will be further discussed.

Reading Ability and Reading Ability x Grade were significant effects in an analysis of variance of IQ scores. Means for these effects are shown in Table 10. Since each grade level had been given a different intelligence test, it would be best to discuss the grades separately.

The correlations between IQ and reading achievement subtests shown in Table 12 clearly demonstrated that, for the population used in this study, IQ and reading achievement are more closely related in the fourth grade than in the second. Since these correlations for the fourth grade were high, and since the Reading Ability x Grade interaction was largely due to the difference between fourth-grade good and poor readers, the variables of intelligence and reading achievement are confounded in the fourth grade *Ss* used in this study. Therefore, the Reading Ability x Instructions x Grade interaction for number of trials could very well be due to intelligence instead of reading ability, or an interaction of the two.

An incidental finding of the present study was that over one-third of the *Ss* given the nonmediation instructions reported they had been mediating in some way (Table 13). Although an equal number of *Ss* in each grade was mediating spontaneously, in the second grade the number is again divided about equally between the good and poor readers, but in the fourth grade there was only one poor reader as compared with the five good readers who reported mediating. The Fisher exact probability test showed that the fourth-grade distribution of mediators and non-

mediators approached a significant level, suggesting that good readers may be more likely to mediate spontaneously. Also, a trend was indicated that there may be an interaction between reading ability and grade operating that may affect tendency to mediate spontaneously. The results of the Fisher tests are roughly comparable to the Grade x Reading Ability x Instructions interaction for number of trials. Therefore, this latter interaction may be explained in terms of spontaneous mediation as well as intelligence, although these two constructs may well be closely related to each other.

Jensen & Rohwer (1965) had found that as age increased, the differences between the groups given different instructions decreased, but there was still a significant difference at the second- and fourth-grade levels. They had raised the possibility that the older *Ss* were mediating spontaneously but had gathered no data to support such a hypothesis. The data gathered in the present study indicates that at least some *Ss* at the lower grade levels were aware of mediating spontaneously, and the suggestion is that this phenomenon may be more likely to occur in children of higher intelligence and/or achievement level.

The latter hypothesis, that children of higher intelligence and/or achievement levels may be more likely to mediate spontaneously, is worth further exploration. A future, well-designed experiment could shed some light on the question. For present purposes, however, some of the data from this study were compared; namely, the IQ scores of the spontaneous mediators vs. those of the nonmediators. The results of this comparison are as follows:

(1) The spontaneous mediators and nonmediators of each grade level were first compared. The mean IQ, standard deviation, and number of *Ss* for each group are shown in Table 14. A *t* test for the difference between the means was nonsignificant for the fourth grade, and barely reached the .05 level of significance using a one-tailed test for the second grade.

(2) With grades combined, the mean IQ and standard deviation for the spontaneous mediators were 106.55 and 12.18, respectively, and for the nonmediators these figures were 107.33 and 9.85. The difference between these figures is negligible.

A comparison between the good and poor readers, to see whether achievement level is associated with the probability of spontaneous mediation, is impossible to make using the data of the present study for three reasons. First, there were differences in IQ between the good and poor readers, confounding these two variables; thus, such a comparison would tell nothing about achievement level alone. Second, the grade levels could not be combined for such a comparison because each had been given a different reading achievement test. And third, the sample size is too small to permit such a comparison at each grade level.

Thus, the previously demonstrated relationship between PA learning and reading ability was not found in this study. Yet there was evidence that reading ability may be closely associated with both intelligence and the tendency to mediate spontaneously, and there may be interactions among these factors. The exact nature of this interaction needs clarification through future research. Also, techniques for identifying spontaneous mediators should be developed and used. Finally, the type of PA task may be the crucial factor in good and poor readers' PA learning. The fact that the present PA task comprised pictorial rather than verbal items may be the basis for the most straightforward explanation for the lack of a difference in the good and poor readers' overall performance. Further research is, of course, needed.

Table 14. Mean IQs, Standard Deviations, and Numbers of Mediating and Nonmediating Namers

	Grade 2		Grade 4	
	Mediators	Nonmediators	Mediators	Nonmediators
Mean	100.80	111.55	111.33	102.70
S.D.	14.81	6.67	7.81	10.99
N	5	11	6	10

VI
SUMMARY

ROLE OF CUES

In the four studies reported, it was shown that certain cues affect the rate of learning a PA list, but each subject's selection from available cues is also an important determiner of learning speed. The first three experiments indicated that color cues may facilitate learning and/or retention if other, more powerful, cues are absent or ignored by the subjects. In Experiment II, color enhanced learning, while in Experiment III, color did not affect the learning rate, but the removal of color had an adverse effect on subsequent performance; thus, color cues were better than no cues at all. However, order of presentation is another factor to be considered, for order also appears to have some cue value (Experiment III). It was demonstrated in Experiment IV that verbal mediators are extremely powerful cues regardless of type of materials, grade, and reading ability. The questions that still remain pertain to the relationship among all of the possible cues. Can they be placed on a continuum of facilitation? If so, how do they stand in relation to each other? If a certain type of cue aids initial learning, does it also aid retention or relearning?

READING ABILITY

Differences in rate of learning by good and poor readers were apparent in Experiments I and II, but not in Experiment IV, although in the latter intelligence was confounded with reading achievement in the fourth grade. Furthermore, the first two studies differed from the fourth in the nature of the stimulus materials (word-like stimuli as opposed to pictures), and this may account for the difference in results.

In Experiment IV, it was also suggested that good readers may be more apt to provide their own verbal mediators than poor readers, but that this trend may also be a function of grade/age level. That is, older children have had more learning experiences and verbal experiences on which to base future learning strategies, and good readers have had more successful verbal learning experiences than poor readers. In the first two studies, where the good and poor readers did differ, the stimulus materials and task were much more reading-like than in the fourth study, which may have enabled the good readers to capitalize on their more successful, and probably broader, verbal experiences. That is, if good readers have learned efficient methods of association with the positive reinforcement of success, the probability of their using appropriate methods in a similar situation is increased.

CUES, READING ABILITY, AND GRADE

The trends noted in Experiment I indicate that the good readers and the sixth graders benefited more from color cues, but the opposite was noted in Experiment II. However, these were trends and not significant interactions, and they may reflect only random error. On the other hand, the increased intralist similarity in Experiment II may have affected the direction of these trends; as shown in Experiment III, the second graders learned faster with low intralist similarity. The question still remains as to whether the results of Experiment III would be the same with other grade levels and with different reading levels.

In Experiment IV, the significant three-way interaction showed that all the groups benefited greatly from the cues, but the fourth-grade good readers did well even without the cues. This finding was discussed in terms of intelligence and spontaneous mediation. That is, the fourth-grade good readers had higher IQs than the fourth-grade poor readers, and they had been providing their own cues even in the absence of instructions to do so. The exact nature of the relationships among intelligence, reading achievement, grade level, and spontaneous verbal mediation still needs much clarification.

BIBLIOGRAPHY

Archer, E. J. Re-evaluation of the meaningfulness of all possible CVC trigrams. *Psychological Monographs*, 1960, 74, Whole No. 497.

Birnbaum, I. M. Context stimuli in verbal learning and the persistence of associative factors. *Journal of Experimental Psychology*, 1966, 71, 483-487.

Bugelski, B. R., & Sharlock, D. P. An experimental demonstration of unconscious mediated association. *Journal of Experimental Psychology*, 1952, 44, 334-338.

Cooper, C. S. The relationships among reading ability, grade level, and syntactical mediation in paired-associate learning. Unpublished master's thesis, University of Wisconsin, 1968.

Crannell, C. W. Code learning and color. *Journal of Psychology*, 1964, 58, 295-299.

Davidson, R. E. Mediation and ability in paired-associate learning. *Journal of Educational Psychology*, 1964, 55, 352-356.

Dulsky, S. G. The effect of change of background on recall and relearning. *Journal of Experimental Psychology*, 1935, 18, 725-740.

Giebink, J. W., & Goodsell, L. L. Reading ability and associative learning for children with a visuomotor deficit. Unpublished manuscript, University of Wisconsin, 1967.

Hays, W. L. *Statistics for psychologists*. New York: Holt, Rinehart, and Winston, 1963.

Hill, F. A., & Wickens, D. D. The effect of stimulus compounding in paired-associate learning. *Journal of Verbal Learning and Verbal Behavior*, 1962, 1, 144-145.

Jenkins, J. J., & Bailey, V. B. Cue selection and mediated transfer in paired-associate learning. *Journal of Experimental Psychology*, 1964, 67, 101-102.

Jensen, A. R., & Rohwer, W. D., Jr. Syntactical mediation of serial and paired-associate learning as a function of age. *Child Development*, 1965, 36, 601-608.

Jones, J. K. Colour as an aid to visual perception in early reading. *British Journal of Educational Psychology*, 1965, 35, 21-27.

Newman, S. E., & Taylor, R. Context effects in paired-associate learning as a function of element-sharing among stimulus terms. *Journal of Verbal Learning and Verbal Behavior*, 1963, 1, 243-249.

Otto, W. The acquisition and retention of paired-associates by good, average, and poor readers. *Journal of Educational Psychology*, 1961, 52, 241-248.

Otto, W. Color cues as an aid to good and poor readers' paired-associate learning. *International Reading Association, 1967 Conference Proceedings*, 1968, in press. (a)

Otto, W. Elementary pupils' use of cues in paired-associate learning. *Psychology in the Schools*, 1968, in press. (b)

Otto, W. Intralist similarity, order of presentation and color in children's paired-associate learning. *Psychonomic Science*, 1968, in press. (c)

Rohwer, W. D., Jr. The verbal facilitation of paired-associate learning. Unpublished doctoral dissertation, University of California, Berkeley, 1964.

Saltz, E. Compound stimuli in verbal learning: Cognitive and sensory differentiation versus stimulus selection. *Journal of Experimental Psychology*, 1963, 66, 1-5.

Samuels, S. J., & Jeffrey, W. E. Intralist similarity and facilitation of paired-associate learning by fixed order presentation. *Psychonomic Science*, 1966, 5, 141-142.

Siegel, S. *Nonparametric statistics for the behavioral sciences*. New York: McGraw-Hill, 1956.

Sunderland, D. M., & Wickens, D. D. Context factors in paired-associate learning and recall. *Journal of Experimental Psychology*, 1962, 63, 302-306.

Underwood, B. J., Ham, M., & Ekstrand, B. Cue selection in paired-associate learn-

ing. *Journal of Experimental Psychology*, 1962, 64, 405-409.

Walters, R. H., & Doan, H. Perceptual and cognitive functions of retarded readers. *Journal of Consulting Psychology*, 1962, 24, 355-361.

Walters, R. H., & Kosowski, I. Symbolic learning and reading retardation. *Journal of Consulting Psychology*,1963, 27, 75-82.

Weiss, W., & Margolius, G. The effect of context stimuli on learning and retention. *Journal of Experimental Psychology*, 1954, 48, 318-322.